The Effects on the Amount of BOD and SS Discharges

The regressions of DBOD, the ratio of discharges of BOD after the surcharge to the initial level of discharges, are shown in Table IV.17. After experimenting with different regressions on the pooled data, the best results were found with PBOD, LIMB and SIZE as dependent variables. In some cases, however, even better results were obtained using the inverse of PBOD; in effect this allows for a nonlinear relationship within the framework of the linear regression model.

Both forms of the regression equation were used for both the pooled sample and the separate industry samples. In almost every case, except the textile industry, the coefficient of LIMB is positive, as we would expect. That is, a higher BOD exemption is associated with a greater increase or a smaller decrease in BOD discharges, and conversely. Also, in almost every case, the coefficient of PBOD or (1/PBOD) is significant and has the expected sign (a higher price leads to a lower DBOD). The only exceptions are the dairy and canning industries (in the latter the coefficient is not significant); in these cases alone a higher BOD charge did not have a negative effect on the growth of BOD discharges.

In the linear probability model, the dependent variable is DUMBOD, which takes the value 1 if BOD discharges have declined (i.e. DBOD<1.0), and zero otherwise. In this case, we would expect LIMB and (1/PBOD) to have negative coefficients, and PBOD to have a positive coefficient. The resutls for the regressions on the pooled data are shown in Table IV.18. Here LIMB generally does not have a significant coefficient

Table IV.17

REGRESSIONS ON DBOD, POOLED SAMPLE & SEPARATE INDUSTRIES

Form 1

sic	INDEP VAR / DEP VAR	CONST	PBOD	LIMB	SIZE	$\bar{R}^2$	#OBS
Pooled Sample	DBOD	.3777	-.00198	.00265	.636	.165	
		(3.01)	(0.52)	(3.87)	(3.68)		157
1	DBOD	.00563	-.00922	.00404	.6796	.730	
		(0.47)	(3.69)	(15.33)	(9.47)		19
2	DBOD	.00414	.00275	.00548	.0197	.785	
		(0.28)	(1.41)	(15.45)	(0.22)		22
3	DBOD	-.0024	.0502	.00047	.395	.494	
		(0.18)	(9.92)	(1.25)	(3.37)		10
4	DBOD	.015	.0258	.00066	.9043	.271	
		(0.32)	(2.81)	(0.8)	(3.55)		28
5	DBOD	.0	-.112	-.130	42.54	.765	
		(0.0)	(13.22)	(11.24)	(11.9)		6
6	DBOD	.0117	-.0161	-.00002	1.82	.348	
		(0.49)	(4.18)	(0.02)	(10.66)		15
7	DBOD	-.0036	.3634	-.0104	.229	.448	
		(0.18)	(9.75)	(7.04)	(1.19)		10
8	DBOD	.031	.1509	-.0019	-.411	.226	
		(0.83)	(2.79)	(0.49)	(0.35)		12

Table IV.17

REGRESSIONS ON DBOD, POOLED SAMPLE & SEPARATE INDUSTRIES

Form 2

SIC	INDEP VAR / DEP VAR	CONST	1/PBOD	LIMB	SIZE	$\bar{R}^2$	#OBS
Pooled Sample	DBOD	.3136	.01	.0028	.5507	.190	
		(2.48)	(2.03)	(4.62)	(3.11)		157
1	DBOD	-.00103	.0111	.0039	.2526	.783	
		(0.1)	(8.33)	(21.46)	(3.25)		19
2	DBOD	.0051	-3.676	.0067	.042	.794	
		(0.35)	(3.41)	(18.19)	(0.49)		22
3	DBOD	.0066	-2.34	.0036	.7404	.315	
		(0.43)	(0.99)	(7.42)	(5.43)		10
4	DBOD	.0227	6.927	.00062	1.057	.259	
		(0.49)	(2.1)	(0.64)	(4.24)		28
5	DBOD	.0	23.24	-.0168	4.955	.760	
		(0.0)	(13.22)	(4.97)	(5.76)		6
6	DBOD	-.0008	.0149	.0021	.648	.453	
		(0.03)	(6.08)	(2.62)	(2.69)		15
7	DBOD	.0055	4.365	.00267		.282	
		(0.24)	(4.80)	(3-0)	(3.65)		10
8	DBOD	-.0007	11.136	.00853	-1.028	.439	
		(0.02)	(9.60)	(12.12)	(3.77)		12

TABLE IV.18 REGRESSIONS OF DUMBOD AND TOBBOD, POOLED SAMPLES

#	Indep. Var. / Dep. Var.	CONST.	PBOD	1/PBOD	LIMB	SIZE	$\bar{R}^2$	#OBS
1	DUMBOD	0.3842	.00472		-.00013	-.1206	.070	157
		(5.27)	(4.19)		(0.5)	(2.25)		
2	DUMBOD	0.485		-.000137	.000037	0.1595	.017	157
		(6.00)		(0.09)	(0.13)	(2.89)		
3	TOBBOD	.6889	-.00045		0.00042	.01315	.000	66
		(7.88)	(0.38)		(1.35)	(0.19)		
4	TOBBOD	.735		-.00384	-.00068	.0482	.037	66
		(8.47)		(1.81)	(2.08)	(0.69)		

(i.e., it does not affect the probability that BOD discharges will fall). The coefficient of PBOD or its inverse, however, is usually significant and has the predicted sign.

The separate industry regressions, shown in Table IV.19, tend to confirm the results of Table IV.17. The coefficient of LIMB is generally significant in these separate industry equations and has the predicted sign in most cases. The coefficient of PBOD and/or (1/PBOD) is almost always significant, and again has the predicted sign for all industries except the dairy and canning industries, and the paper industry (for which we do not have the regression with PBOD as an independent variable).

Next we analyze the response of SS discharges to the surcharge system. In our preliminary analysis of DSS we found that better results were generally obtained using (1/PSS) and LIMS as independent variables rather than PSS or any other variables (including SIZE which generally had an insignificant coefficient). The regressions of DSS on these two variables, for both the pooled sample and the separate industries are shown in Table IV.20. In this table, the coefficient is almost everywhere significant and has the predicted (positive) sign, except for the pooled regression, where it is negative and insignificant. The coefficient of (1/PSS) is also generally significant, and has the predicted sign except for the canning and miscellaneous food processing industries, and the pooled regression where it, too, is negative but insignificant. The explanatory power of the pooled equation is extremely poor, while that of the separate industry equations is again very good.

TABLE IV.19. REGRESSIONS OF DUMBOD, SEPARATE INDUSTRIES & POOLED SAMPLE

SIC	INDEP.VAR. / DEP.VAR.	CONST.	PBOD	LIMB	$\bar{R}^2$	CONST.	1/PBOD	LIMB	$\bar{R}^2$	#OBS
1	DUMBOD	.3913	.00491	-.00048	.000	2.082*	-0.208	-.0065	.286	11
		(1.78)	(1.00)	(0.5)		(3.36)	(3.03)	(2.73)		19
2	DUMBOD	-.1431	-.0286	.00386	.259	-.7750	4.08	.0034	.126	
		(0.38)	(3.81)	(2.41)		(1.76)	(2.71)	(1.99)		22
3	DUMBOD	1.352	-.0262	-.00146	.139	.3075	7.993	-.00124	.169	
		(3.26)	(1.95)	(1.68)		(0.95)	(2.14)	(1.45)		10
4	DUMBOD		N.A.			.364	-5.703	.00139	.195	
						(2.08)	(3.96)	(2.33)		28
6	DUMBOD	.475*	.01176	-.0012	.1811	2.785	-.0229	-.00787	.03	
		(2.04)	(2.23)	(1.19)		(2.08)	(1.69)	(1.72)		15
7	DUMBOD		N.A.			-2.146*	11.61	.00448	.541	
						(2.48)	(3.87)	(1.96)		10
8	DUMBOD		N.A.			.8442	-2.604	-.0012	.000	
						(1.92)	(1.35)	(1.01)		18
9	DUMBOD	1.328	.00417	-.00351	.120	1.694	-2.53	-.00376	.091	
		(2.83)	(2.46)	(2.03)		(3.80)	(1.88)	(2.17)		35
	DUMBOD	.3232	.00526	-.000156	.058	.4231	-.00089	.000011	.000	157
		(4.81)	(4.71)	(0.6)		(5.32)	(0.55)	(0.04)		

* First stage linear probability model equation (second stage unobtainable).

TABLE IV.20 REGRESSIONS OF DSS, POOLED SAMPLE & SEPARATE INDUSTRIES

SIC	INDEP.VAR. / DEP. VAR.	CONST.	1/PSS	LIMS	$\bar{R}^2$	#OBS
1	DSS	.00861	.00395	.00484	.532	
		(0.38)	(1.24)	(17.34)		18
2	DSS	.00768	.0134	.00456	.626	
		(0.4)	(8.53)	(18.88)		23
3	DSS	.00847	-5.96	.00482	.609	
		(0.71)	(8.33)	(16.78)		15
4	DSS	.0144	-1.363	.00457	.323	
		(0.36)	(0.73)	(7.15)		31
5	DSS	.0001	.0173	.00446	.672	
		(0.01)	(19.43)	(22.7)		6
6	DSS	.0622	.00746	.00928	.000	
		(0.59)	(0.69)	(4.87)		10
7	DSS	.0244	11.268	.00021	.087	
		(0.21)	(7.96)	(0.98)		13
8	DSS	.0384	6.22	.00079	.401	
		(1.00)	(10.31)	(1.59)		23
9	DSS	.00969	.00957	.003114	.563	
		(0.42)	(11.08)	(14.48)		39
	DSS	1.378	-.00323	-.00029	.000	
		(4.17)	(0.51)	(0.23)		178

When the dependent variable is DUMSS, in the pooled regressions--shown in Table IV.21--the variables LIMS, PSS and (1/PSS) all have the predicted sign. However, in the separate industry regressions shown in Table IV.22, almost all the coefficients of both LIMS and PSS or (1/PSS) have the "wrong" sign. Thus we are finding that a higher LIMS or a lower PSS implies a higher probability that discharges of SS will decrease.

We can suggest the following explanation for this counter-intuitive result. We observed earlier (see Table IV. 11) the negative correlation between the charge parameters pertaining to BOD and those pertaining to SS. Thus a higher BOD exemption limit (LIMB) is generally associated with a lower SS exemption limit (LIMS). Similarly the discharge prices PBOD and PSS are also inversely correlated. Combining this with the results of our regressions on the response of BOD discharges we may say that in cities where PSS is lower, PBOD is likely to be higher and for most industries this leads to a decrease in discharges of BOD. For many industries, too, discharges of BOD and SS change in the same direction. Hence a lower PSS is associated with a reduction in SS discharges. This explains most, but not all, of the perverse results. For the rest, further research is required.

The Effect on Concentrations of BOD and SS

We should have anticipated that the regressions with changes in waste concentrations as dependent variable might produce some peculiar results because these variables are themselves the ratios of two separate variables--the change in BOD or SS discharges and the change in sewage flows. Since numerator and denominator are both functions

Table IV. 21 REGRESSIONS OF DUMSS AND TOBSS, POOLED SAMPLE

#	INDEP VAR / DEP VAR	CONST	PSS	1/PSS	LIMS	SIZE	$\bar{R}^2$	# OBS
1	DUMSS	.5135	-.005		.00029	-.0687	.011	
		(8.33)	(2.05)		(1.37)	(1.28)		178
2	DUMSS	.2621		.00388	.000821	-.05055	.036	
		(3.27)		(3.69)	(3.14)	(0.96)		178
3	TOBSS	.5195	.00183		-.000039	.08333	.000	
		(9.06)	(0.77)		(0.20)	(1.56)		86
		.5148		.000289	.000061	.08232	.000	
		(5.66)		(0.26)	(0.21)	(1.54)		86

TABLE IV.22 REGRESSION OF DUMSS, SEPARATE INDUSTRIES & POOLED SAMPLE

Sic	Indep. Vars. / Dept. Vars.	Const.	PSS	LIMS	$\bar{R}^2$	Const.	1/PSS	LIMS	$\bar{R}^2$	No. OBS
1	DUMSS	.7757	-.01215	-.000265	.012		NA			
		(2.63)	(1.45)	(0.25)						18
2	DUMSS	.2678	-.0033	.00618	.000		NA			
		(1.51)	(0.46)	(0.8)						23
3	DUMSS	.0894	-.00434	.00154	.200	.0465	2.3317	.000695	.114	
		(0.22)	(0.42)	(1.98)		(0.13)	(1.67)	(0.53)		15
4	DUMSS	-.0542	.00674	.00181	.100	-.0522	-2.2896	.0029	.008	
		(0.26)	(1.22)	(2.83)		(0.1)	(1.49)	(1.44)		31
6	DUMSS	.3859	-.00726	.000153	.000	-.2069	.00707	.00165	.114	
		(1.74)	(0.82)	(0.18)		(0.9)	(2.3)	(1.83)		10
7	DUMSS	1.94	-.5952	.00288	.515	-.8632	3.2425	.0006	.434	
		(3.68)	(2.62)	(1.67)		(1.29)	(2.17)	(0.55)		13
8	DUMSS	.1701	.00129	.000953	.055	.0388	.00461	.00141	.155	
		(1.41)	(0.22)	(2.29)		(0.38)	(1.88)	(3.72)		23
9	DUMSS	.7052	-.01718	.000453	.090	-.3673	.01082	.00306	.063	
		(8.47)	(3.13)	(1.15)		(0.93)	(2.67)	(2.4)		45
	DUMSS	.4891	-.00524	.00029	.009	.2321	.00405	.000852	.037	
		(8.33)	(2.16)	(1.37)		(3.1)	(3.88)	(3.26)		189

of the charge parameters, the relationship between their ratio and the charge parameters reflects the interaction of two separate patterns of causation. The simplest procedure is to present the results of all the regression equations and then to suggest an explanation, starting with the results for BOD concentration.

The regressions of the percentage change in BOD concentrations, DCBD, for the pooled sample are shown in Table IV.23. On the basis of these and other preliminary regressions we decided to focus on PFLO, LIMB and PBOD (or 1/PFLO, LIMB and 1/PBOD) as dependent variables (note that SIZE appears to have no effect on the change in BOD concentration). The results of these regressions for both the separate industries and pooled data are shown in Table IV.24. The regressions of the dichotomous charge variable DUMCBD (which takes the value 1 of BOD concentrations fell and 0 otherwise) are shown in Tables IV.25 and IV.26.

In all these regressions, the only explanatory variable which behaves exactly as one might expect is LIMB, which generally has a significant positive coefficient in the DCBD equations and a significant negative coefficient in the DUMCBD equations. The implication of these coefficients is that the higher the BOD concentration below which surcharge payments are exempted, the lower the incentive to reduce the actual concentration of BOD in waste discharges.

In the separate industry equations for BOD discharges--Tables IV.17 and IV.19--we found that the regression coefficients of PBOD generally implied that a higher surcharge on BOD discharges led to less BOD discharges. However in the industry regression equations for the change in BOD concentrations (DUMCBD)--Table IV.24--we find that, while in

TABLE IV. 23

REGRESSIONS OF DCBD, POOLED SAMPLE

Number	Indep.Var. / Dep.Var.	Const.	PFLO	PBOD	PSS	LIMB	LIMS	PAB	PAS	PAM	SIZE	$\bar{R}^2$
1	DCBD	1.024	-.08728	.0013	.0201	.000167	.0001				-.05188	.019
		(3.43)	(0.78)	(0.25)	(2.06)	(0.18)	(0.11)				(0.3)	
2	DCBD	1.04	-.0911					.07633	1.0566		-.05718	.044
		(4.74)	(0.79)					(0.32)	(3.24)		(0.74)	
3	DCBD	1.147	0.192			-.00035	.00094			-.38009	-.0227	.018
		(3.94)	(1.12)			(0.38)	(1.41)			(1.86)	(0.13)	

IV.24. REGRESSIONS OF DCBD, SEPARATE INDUSTRIES & POOLED SAMPLE

Sic	Indep. Var. / Dept. Var.	Const.	PFLO	PBOD	LIMB	$\bar{R}^2$	# OBS
1	DCBD	.0084	.04336	.01162	.002616	.570	
		(0.45)	(0.78)	(3.05)	(7.47)		29
2	DCBD	.00277	-.5222	.02187	.00622	.858	
		(0.22)	(9.27)	(10.05)	(23.07)		30
3	DCBD	.00004	-.7515	.06397	.00328	.823	
		(0.43)	(11.54)	(19.03)	(11.39)		16
4	DCBD	.01246	.1789	.0285	.00112	.559	
		(0.55)	(2.0)	(6.65)	(2.55)		29
5	DCBD	0.0	-5.729	.14243	.03988	.561	
		0.0	(6.93)	(6.67)	(8.56)		6
6	DCBD	.00254	.2678	-.0145	.00247	.689	
		(0.26)	(11.4)	(8.63)	(9.88)		15
7	DCBD	0.0	-8.355	1.2191	-.039	.536	
		0.0	(3.54)	(4.58)	(4.37)		10
8	DCBD	.01316	-4.177	0.6451	-.00267	.247	
		(0.25)	(3.24)	(4.42)	(0.96)		14
9	DCBD	-.0011	-.5583	.00925	.00739	.758	
		(0.06)	(7.33)	(3.56)	(19.84)		37
		0.5112	.01482	-.00085	.00262	.065	
		(3.35)	(0.14)	(0.18)	(3.83)		186

Table IV.25 REGRESSIONS OF DUMCBD AND TOBCBD, POOLED SAMPLE

#	Indep. Var. / Dep. Var.	Const.	PFLO	PBOD	1/PBOD	LIMB	SIZE	$\bar{R}^2$	# OBS
1	DUMCBD	.4828	.07346	.00141		-.000408	-.069	.035	
		(6.14)	(2.23)	(0.8)		(1.65)	(1.34)		186
2	DUMCBD	.4673	.08967		-.000185	-.000329	-.072	.030	
		(5.82)	(3.33)		(0.11)	(1.19)	(1.4)		186
3	TOBCBD	.6832	-.01884	.000408		-.000162	-.00383	.000	
		(8.21)	(0.50)	(0.27)		(0.62)	(0.07)		92
4	TOBCBD	.6794	-.01177		.000087	-.000147	-.00834	.000	
		(7.97)	(0.44)		(0.05)	(0.48)	(0.15)		92

Table IV. 26

REGRESSIONS OF DUMCBD, SEPARATE INDUSTRIES & POOLED SAMPLE

Form 1

SIC	INDEP VAR / DEP VAR	CONST	PFLO	PBOD	LIMB	$\bar{R}^2$	# OBS
Pooled Sample	DUMCBD	.7851	.038026	.001456	=.001444	.098	
		(11.75)	(0.86)	(0.75)	(5.14)		186
1	DUMCBD	NA					29
2	DUMCBD	1.14*	0.2359	-.02876	-.0013	.292	
		(8.25	(1.81)	(3.54)	(1.41)		30
3	DUMCBD	NA					16
4	DUMCBD	NA					29
5	DUMCBD	-2.092	.9474	-.00587	.00111	.511	
		(2.91)	(3.97)	(1.16)	(1.21)		15
7	DUMCBD	NA					10
8	DUMCBD	NA					20
9	DUMCBD	.7622	.16719	-.002029	-.002794	.231	
		(7.64)	(0.76)	(0.3)	(2.39)		37

* First stage regression of the linear probability model (second stage regression unobtainable).

Table IV. 26

REGRESSIONS OF DUMCBD, SEPARATE INDUSTRIES & POOLED SAMPLE

Form 2

SIC	INDEP VAR / DEP VAR	CONST	1/PFLO	1/PBOD	LIMB	$\bar{R}^2$	# OBS
Pooled Sample	DUMCBD	.7754	-.16621	-.000532	-.000488	.040	
		(8.04)	(4.18)	(0.33)	(1.74)		186
1	DUMCBD	1.767	-.0624	-.01245	-.00375	.114	
		(4.55)	(0.36)	(3.03)	(8.14)		29
2	DUMCBD	.3346	-.11336	3.0038	-.000772	.089	
		(0.99)	(1.52)	(2.63)	(0.66)		30
3	DUMCBD	2.949	-.97943	2.0423	-.0054	.544	
		(4.53)	(2.12)	(0.6)	(3.54)		16
4	DUMCBD	.1687	.05393	1.2033	.000617	.000	
		(0.55)	(0.42)	(0.55)	(1.02)		29
6	DUMCBD	1.849*	-4.508	.004032	.00168	.469	
		(1.17)	(3.38)	(0.23)	(0.28)		15
7	DUMCBD	NA					
							10
8	DUMCBD	.787*	.50032	-6.82	-.00108	.007	
		(0.65)	(0.44)	(1.18)	(0.33)		20
9	DUMCBD	2.554	-.35363	-1.9153	-.006139	.310	
		(7.9)	(4.27)	(1.92)	(4.97)		37

*First stage regression of the linear probability model (second stage regression unobtainable) one/half of the industries a higher BOD surcharge increases the probability that BOD concentrations fall, in the other half a high surcharge reduces the probability that BOD concentrations fall. Moreover in the industry regressions for the percent charge in BOD concentrations (DCBD)--Table IV.26--we find almost uniformly that with a higher surcharge on BOD, if BOD concentrations decrease then they decrease less, and if concentrations increase then they increase more.

The most plausible explanation for these results is that a high BOD surcharge encourages firms not only to reduce BOD discharges but also to reduce the volume of water consumption and sewage discharges. This was the general implication of the regression of sewage flows. In consequence, with a high BOD surcharge, BOD concentrations tend to fall less and may even increase. This hypothesis is illustrated in Figures IV.1 and IV.2. We postulate that the production possibility set facing firms is such that the relationship between BOD discharges per unit of output and sewage flows per unit of output is given by the (possibly non-linear) function AB. Different points along that line corespond to different technologies of production and waste treatment. In the absence of a surcharge on BOD discharges firms operate at a point near B. Their response to the price changes induced by the surcharge is to move down the function towards point A. If the trade-off function is as shown in Figure IV.1 the move towards A leads to an increase in BOD concentrations; if the trade-off function is as shown in Figure IV.2, the move towards A leads to a reduction in BOD concentrations.

The coefficients of the charge on sewage flows, PFLO, are also rather puzzling. This is true both for the equations with volume of

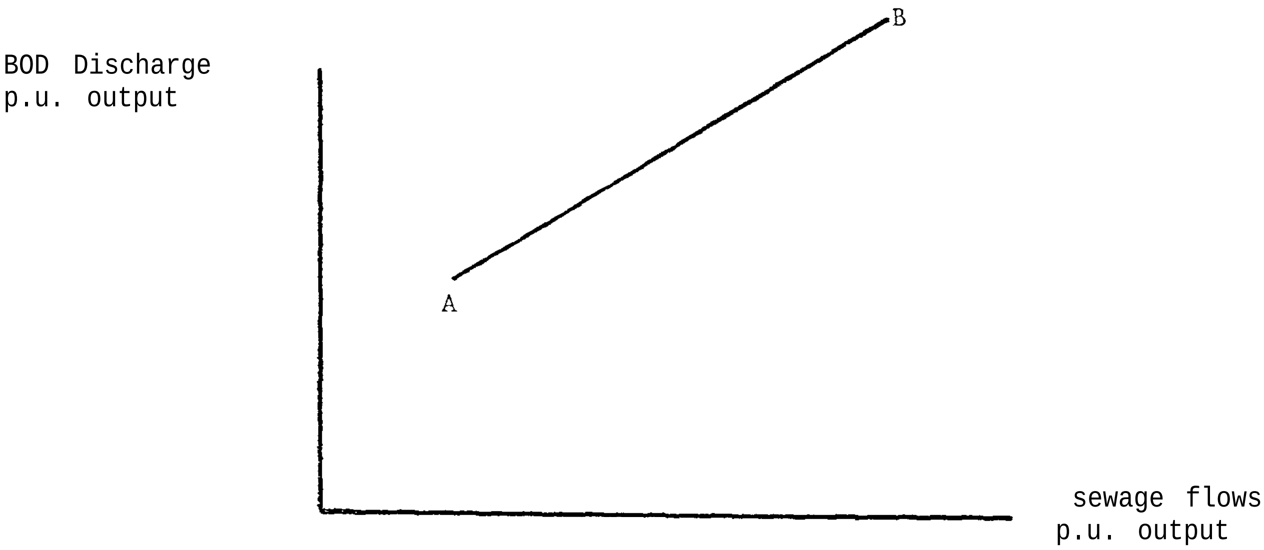

Figure IV.1 One Possible Trade-Off Function Between BOD Discharges and Sewage Flows

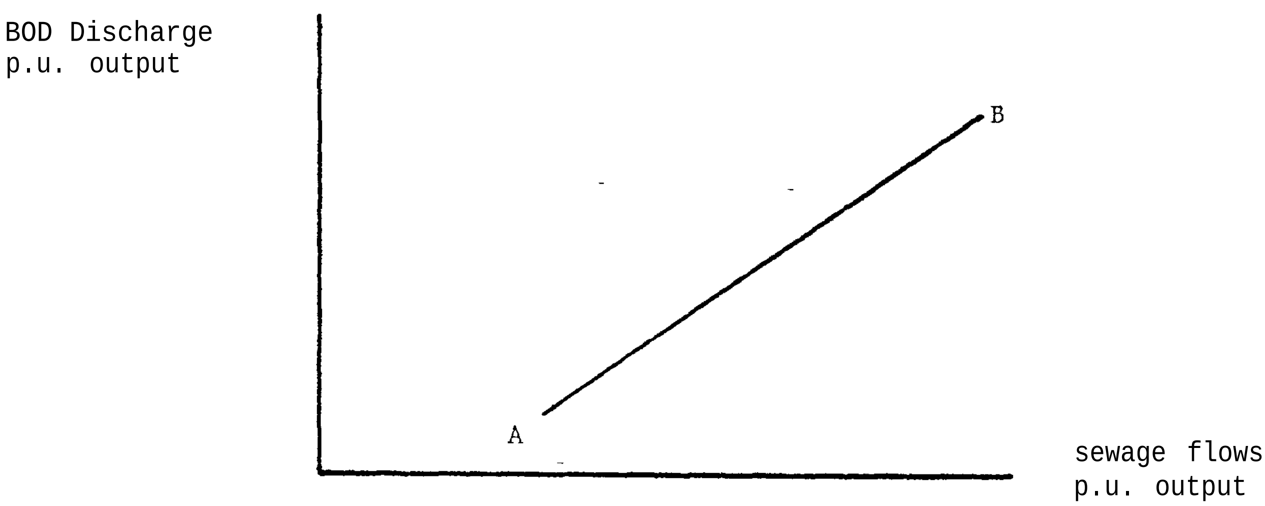

Figure IV.2 A Second Possible Trade-Off Function Between BOD Discharges and Sewage Flows.

sewage flow as dependent variable (presented above in Tables IV.13 and IV.16) and for those with BOD concentration as dependent variable. In the equations for the dichotomous change in sewage flows we found that the coefficient of PFLO was generally negative. That is, a high flow charge implied a greater probability that flows would decrease or stay the same. However, in the equations for the percent change in sewage flows we found that the coefficient of PFLO was generally positive which implies, for a high flow charge, that if flows decrease then they decrease less. Why should this be so?

The reason may be connected with the special nature of the PFLO variable. The other price variables in this study--PBOD, PSS, etc.--are essentially incremental prices. Since there was no surcharge system in operation beforehand they represent the change in discharge prices which firms faced when the surcharge system was introduced. However, in all of our cases there had been a charge on sewage flows in effect before the introduction of the surcharge system. Furthermore, when the surcharge system was introduced the flow charge was not necessarily raised, or, if it was raised, it was usually not raised by very much. Hence the PFLO variable does not represent an increment in prices facing firms.

Suppose we postulate that in cities where flow charges were high (both before and after the introduction of the surcharge) firms had already at least partially adjusted their water consumption and sewage discharges to these prices. Firms in these cities already tended to discharge less before the surcharge system than firms in cities with lower flow charges. In terms of the diagrams in Figures IV.1 and IV.2

these firms were starting out at some point on the trade-off function to the left of B. Then, when the surcharge system was introduced, firms in these cities would still reduce discharges, but they would reduce them less because of their prior adjustment. This hypothesis would explain the contradictory implications of the DFLO and DUMFLO regression.

This hypothesis may also help to explain the regression equations for the change in BOD concentration, as measured by DCBD and DUMCBD. Although the results for DUMCBD (Table IV.26) are rather fragmentary, they show that in many industries a higher flow charge leads to a greater probability that BOD concentrations will fall (which is consistent with Figure IV.2). However the regressions for the DCBD (Table IV.24) show that, for a higher flow charge, if BOD concentrations increase (because flow discharges are reduced even more than BOD discharges) they increase less. This would be explained by the prior partial adjustment in flows in response to the pre-existing high flow charge, which limits the possible reduction in flows after the introduction of the surcharge system.

Turning to the response of SS concentrations, the regressions of the percent change in concentrations for the pooled data are shown in Table IV.27. On the basis of these results we chose to use DFLO, 1/PSS and LIMS as independent variables for the industry equations; these regressions are shown in Table IV.28. The regressions of the dichotomous change variable DUMCSS (which takes the value if 1 of SS concentrations fell, and 0 otherwise) are shown in Tables IV.29 and IV.30.

Table IV.27 REGRESSIONS OF DCSS, POOLED SAMPLE

#	Indep. Var. / Dept. Var.	Const.	PFLO	PBOD	PSS	LIMB	LIMS	PAB	PAS	PAM	SIZE	$\bar{R}^2$
1	DCSS	4.217	.28589	-.04655	.03333	-.00094	-.00976				-.2144	.1106
		(6.31)	(0.92)	(3.54)	(1.58)	(0.38)	(5.0)				(0.61)	
2	DCSS	1.707	.23773					-.67394	-.73548		-.0576	.000
		(4.03)	(0.81)					(1.11)	(0.97)		(0.15)	
3	DCSS	3.743	-1.2673			.00268	-.00686			1.0323	-.0911	.064
		(5.89)	(2.52)			(1.17)	(3.88)			(1.99)	(0.25)	
		Const.	1/PFLO	1/PBOD	1/PSS	LIMB	LIMS				SIZE	
4	DCSS		-.01436	.01305	-.04044	.0027	-.01304				-.2077	.131
			(0.04)	(1.09)	(4.17)	(0.77)	(4.33)				(0.59)	

Table IV. 28 REGRESSIONS OF DCSS,
SEPARATE INDUSTRIES & POOLED SAMPLE

Sic	Indep. Var. / Dep. Var.	Const.	PFLO	1/PSS	LIMS	$\bar{R}^2$	# OBS
1	DCSS	.00436	.08268	.00268	.00327	.531	
		(0.23)	(0.92)	(0.65)	(6.79)		23
2	DCSS	.00664	-.14592	.018805	.00491	.659	
		(0.36)	(1.95)	(6.32)	(12.29)		27
3	DCSS	.0059	.27489	-3.957	.003643	.700	
		(0.57)	(5.34)	(5.9)	(11.61)		15
4	DCSS	.0119	-.13382	-.66233	.00394	.627	
		(0.69)	(1.89)	(0.78)	(9.59)		31
5	DCSS	.0	1.04	-.01964	-.001714	.780	
		0.0	(8.51)	(4.62)	(2.23)		6
6	DCSS	.01482	3.5211	-.11411	-0.015218	.103	
		(0.18)	(10.77)	(8.04)	(5.73)		10
7	DCSS	-.0004	11.242	-2.631	-.00559	.135	
		(0.49)	(3.58)	(0.71)	(2.66)		13
8	DCSS	-.0029	1.1856	11.6678	-.00452	.435	
		(0.05)	(7.98)	(12.29)	(5.26)		24
9	DCSS	.0099	-.1172	.01276	.00364	.586	
		(0.46)	(1.44)	(4.38)	(10.11)		40
10	DCSS	1.3752	.6747	-.02709	-.00307	.039	
		(3.97)	(3.17)	(3.13)	(2.32)		189

Table IV.29 REGRESSIONS OF DUMCSS AND TOBCSS, POOLED SAMPLE

#	Indep. Var. / Dept. Var.	Const.	PFLO	PSS	1/PSS	LIMS	SIZE	$\bar{R}^2$	# OBS
1	DUMCSS	.5124	.06527	-.00936		.00031	-.0536	.050	
		(5.82)	(2.4)	(3.98)		(1.31)	(1.06)		189
2	DUMCSS	.3979	.0044		.003367	.000409	-.0467	.026	
		(4.32)	(0.13)		(2.55)	(1.5)	(0.9)		189
3	TOBCSS	.4988	.05864	-.00079		.000106	.00046	.011	
		(5.21)	(2.0)	(0.3)		(0.43)	(0.01)		100
4	TOBCSS	.4558	.01926		.00216	.00034	.00596	.036	
		(4.68)	(0.5)		(1.59)	(1.21)	(0.11)		100

Table IV.30

REGRESSIONS OF DUMCSS, SEPARATE INDUSTRIES & POOLED SAMPLE

Form 1

SIC	INDEP VAR / DEP VAR	CONST	PFLO	PSS	LIMS	$\bar{R}^2$	# OBS
Pooled Sample	DUMCSS	.4944	.06539	-.00959	.000309	.049	
		(5.73)	(2.4)	(4.09)	(1.31)		189
1	DUMCSS	.3666	.12952	-.009527	.000766	.000	
		(1.01)	(1.29)	(1.17)	(0.74)		23
2	DUMCSS	.1853	.06119	-.009567	.0011	.004	
		(0.51)	(0.64)	(1.35)	(1.17)		27
3	DUMCSS	.6804*	-.15065	-.01065	-.000185	.000	
		(0.81)	(0.67)	(0.59)	(0.11)		15
4	DUMCSS	-.1051	.16821	.000219	.001672	.095	
		(0.4)	(1.88)	(0.04)	(2.12)		31
6	DUMCSS	-1.57*	.69757	-.02785	.0038	.000	
		(0.95)	(1.45)	(1.32)	(1.11)		10
7	DUMCSS	2.651*	-3.6562	-.07293	-.002175	.097	
		(1.39)	(1.02)	(1.34)	(0.95)		13
8	DUMCSS	.7932	-.16522	.005126	-.000256	.050	
		(4.61)	(2.26)	(0.68)	(0.5)		30
9	DUMCSS	.497	.09315	-.019	.00093	.169	
		(2.01)	(1.32)	(3.79)	(1.63)		40

* First stage &regression of the linear probability model (second stage regression unobtainable)

Table IV.30

REGRESSIONS OF DUMCSS, SEPARATE INDUSTRIES & POOLED SAMPLE

Form 2

SIC	INDEP VAR / DEP VAR	CONST	1/PFLO	1/PSS	LIMS	$\bar{R}^2$	# OBS
Pooled Sample	DUMCSS	-.3844	-.00866	.00358	.000451	.028	
		(4.61)	(0.32)	(3.38)	(1.63)		189
1	DUMCSS	-.332*	.0013077	.013317	.003218	.000	
		(0.46)	(0.01)	(1.52)	(1.27)		23
2	DUMCSS	.1519	.02815	.001736	.000749	.000	
		(0.38)	(0.26)	(0.39)	(0.5)		27
3	DUMCSS	.2047	-.01136	2.4785	-.000376	.037	
		(0.58)	(0.09)	(1.27)	(0.34)		15
4	DUMCSS	.07016	-.1446	-.46034	.002578	.062	
		(0.13)	(1.75)	(0.27)	(1.25)		31
6	DUMCSS	.1537	-2.5727	.01592	.005209	.851	
		(1.0)	(4.07)	(23.49)	(9.76)		10
7	DUMCSS	-.9964	.19233	2.7049	.000524	.590	
		(11.06)	(4.8)	(38.41)	(3.22)		13
8	DUMCSS	.3683	.12733	.000936	-.00009	.040	
		(2.38)	(2.23)	(0.33)	(0.17)		30
9	DUMCSS	.07747	-.08972	.00749	0.21361	.052	
		(0.2)	(1.46)	(1.89)	(1.65)		40

* First stage regression of the linear probability model (second stage regression unobtainable)

The interpretation of these results is complicated by two facts. First, the dependent variables are ratios of variables which are each independently functions of the explanatory variables. Second, the explanatory surcharge variables for SS, LIMS and PSS, are negatively correlated with the corresponding surcharge variables for BOD. As we suggested in the previous section, the main response of firms may be to adjust their flow and BOD discharges in response to the BOD surcharge parameters. Also, because of waste treatment technology, BOD and SS discharges often, but not always, change in the same direction. Therefore, the relationship between the change in SS discharges and concentrations to the SS surcharge variables may be very peculiar.

For example, the coefficient of the SS surcharge exemption level, LIMS, is often negative in the regressions of DCSS and positive in the regressions of DUMCSS. This implies that a higher SS exemption limit encourages a <u>reduction</u> in SS concentrations, a result which normally we would not expect. Similarly, the coefficients of PSS and 1/PSS in the regressions of DCSS and DUMCSS imply that a higher surcharge on SS generally leads to a lower probability that SS concentrations fall, and if they do fall, leads to a smaller decline. Finally, the coefficients of PFLO and 1/PFLO in the regressions of DCSS and DUMCSS imply that a higher flow charge generally leads to a lower probability that SS concentrations fall but, if they do increase, they increase more. These results are generally the precise opposite of those obtained for the BOD concentration equations.

Conclusions

We have collected data on the response to sewer service charges levied on discharges of BOD and SS for 219 firms in 9 different industry sectors in 21 cities. We have analyzed the effects of the surcharge system on discharges of BOD and SS, the volume of sewage flows, and the concentrations of BOD and SS.

We have found a significant response to the surcharge system which varies substantially among firms in different industries and among firms of different sizes. The most clear cut response is that of BOD discharges. These fall significantly more where surcharge rates on BOD are higher and where the exemptions for BOD surcharge payments are lower. The surcharge system does not have a uniform effect on the volume of sewage discharges in all industries. In many industries the system encourages a reduction in water use and sewage flows. In some other industries it encourages an increase in water use in order to dilute wastes and reduce surcharge payments. In the former case where higher surcharge rates lead to less BOD discharges, they are also associated in some cases with increases in BOD concentrations, where sewage flows fall proportionately more than BOD discharges.

Although the explanatory power of our regression equations--especially the individual industry equations--is generally good, their implications are not always consistent or intuitively explicable. We need to obtain more data and conduct further research before we reach any definite conclusions.

There are several directions in which we wish to extend this analysis. Firstly, we propose to experiment with additional explanatory variables which make allowances for the initial levels of sewage flow charges and of sewage flows and BOD and SS discharges. Also we would like to include the marginal costs of waste treatment by the individual firms. For firm decision makers the relevant price variable may really be the ratio of the surcharge rates to the marginal costs of self-treatment. These marginal costs may be roughly constant for different firms in the same industry, in which case we are implicitly allowing for them by running separate industry regressions. However, the differences in marginal treatment costs may transcend the differences in industries, in which case we should include them explicitly in the regression equations.

Secondly, we propose to explore in greater detail the differences in industry response to the surcharge system, and to investigate the question of whether certain industries can validly be grouped together because of their similar response functions. We hope to conduct formal significance tests of these differences.

Thirdly, we have now obtained and propose to implement a computer program for conducting Probit and Tobit analyses which is superior to the linear probability technique used so far. The Tobit model is conceptually very attractive. It allows for one equation to determine whether or not a change (e.g., a reduction in waste discharges) occurs, and another equation to predict the extent of the change, given that it occurs. Different variables may appear in the two equations, or the same variables may appear but may have a different relative importance. We would like to employ this model now that we have a satisfactory estimation program.

So far, we have studied the responses of sewage flow, DOB and SS discharges, and BOD and SS concentrations separately. As the discussion at the end of the last section indicates, this may be unwise; the causal relationships in one equation may influence those of another. There are several ways to deal with inter-relationships among the dependent variables. One method is generalized least squares applied to the separate regressions estimated simultaneously--Zellner's so-called "seemingly unrelated regression model." Another technique is to use Probit analysis, applied to compound events: e.g., "flow falls and BOD concentration falls" versus "flow falls and BOD concentration rises."

Finally, we propose to pursue an analysis of the time patterns of responses to the surcharge system and also to investigate the absolute values of the response variables (the levels of sewage flow, BOD and SS discharges, and BOD and SS concentrations 2 to 4 years after the introduction of the surcharge) to see whether they vary systematically as functions of the parameters of the surcharge system.

FOOTNOTES

1. This, and the following information comes from International City Management Association, Urban Data Service: Sewer Services and Charges, February 1970, Vol. 2, No. 2.

2. Cited in The Economics of Clean Water, Vol. 1, EPA, 1972

3. One city estimated the cost of compiling the data at $7-10,000. Other cities appeared to be able to provide similar data at a much lower cost (and at no charge to us).

4. In those cases where the charge on sewage flow was in the form of a declining block tariff, we set the value of PFLO equal to the marginal charge facing each firm, given its initial volume of sewage discharges.

5. We have separate information on the volume of water use and sewage discharges only for one city, 051, which , fortunately, provided us with data on 70 firms over a time period of about 6 years. In about one third of the firms in that city there was a reduction in the ratio (sewage discharge/water consumption) from 1 usually to .95 - .9 over a period of 3 or 4 years.

6. In his study Elliott assumes that BOD and SS change in direct proportion to one another, without offering any evidence, and bases his model on the combined response of BOD plus SS.

7. This is actually slightly less than the full set of data which we could have used; because of delays in deseasonalizing long time series we could only include about 35 of the 60 firms in one city, 051, and we had to omit about 35 firms from three other cities. Thus our maximum present data set would cover about 255 firms in 21 cities (excluding the 33 firms in 134, 166, 114 and 117). In addition we expect to receive data from another large city with observations on about 60 firms over about 6 years. This data is in transit at the time of writing.

APPENDIX IV.A: SURVEY INSTRUMENTS

CITY SURVEY

1. Initial Telephone Survey

2. In-Depth Survey--Cover Letter
   Questionnaire

INITIAL QUESTIONNAIRE

We are working with Professor Marc Roberts of Harvard University (Economics Department) on a study funded by the Environmental Protection Agency to investigate the effects of special surcharges on the quality of industrial wastes discharged into municipal sewerage systems. (We want to find out whether these surcharges are leading to changes in the amount of BOD and other pollutants dischargcd by industries into municipal systems)

CITY :

DEPARTMENT :

Phone No:

OFFICIAL CONTACTED

1. Do you actually levy a special surcharge ?

   When was it first introduced ?

   (What is the surcharge - how calculated)

2. Roughly how many firms pay the surcharge ?

   What sort of industries are these firms in ?

3. Do you monitor the discharges of each firm separately ? Would you have on record the discharges of each firm for each year during which the surcharge has been in operation ?

4. Did they monitor wastes discharges (ie quality of wastes - lbs of BOD etc) for individual firms prior to the introduction of the surcharge ? Is this data recorded?

If we sent a formal letter to you explaining the purpose of this study, would this data on wastes discharges by individual firms over the years (ie items 3,4) be available to us. We would preserve the confidentiality of the firms and the cities in the study. The data could he transmitted to us in whatever form was convenient - by mail (on a questionnaire, if necessary), by further telephone conversation, or possibly by a field visit - we plan to make some field visits, when we have found out what data is available in different cities.

HARVARD UNIVERSITY

DEPARTMENT OF ECONOMICS

MARC. J. ROBERTS
Associate Professor

LITTAUER 230
CAMBRIDGE, Massachusetts 02138
(617) 495-2126

July , 1973

xxxxxxxxx
xxxxxxxxx
xxxxxxxxx
xxxxxxxxx
xxxxxxxxx

Dear Mr. xxxxxxx

We are conducting a study under a research grant from the Environmental Protection Agency to investigate the effects of charges based on sewage strength on the discharge of industrial wastes into municipal sewage systems. We are interested in finding out how firms respond to these charges over time (for example, do firms respond by reducing waste loads?) and how that response varies among industries.

Our assistant, David Garvin, spoke with Name recently, and he recommended that we write to you. In order to conduct our analysis, we would like your assistance in obtaining the following data:

1. The formula by which sewer charges for industries are assessed.

2. The names of the firms paying these charges in each year and the industry in which they operate.

3. The amount of wastes and wastewater discharges by each of these firms in each year.

In addition, we would very much like to have your more general comments on the operation and the effectiveness of the charge system.

WC realize that this is a large request to make and that your time is scarce. We would like you to use whatever method is most convenient for you to transmit the data. We have enclosed a set of data sheets and an addressed envelope, if that would best suit your needs. As an alternative, please feel free to call us collect and have someone read us the information over the telephone. If it would be easiest for you just to make or send copies of existing materials, please follow that course.

Whichever method you choose, we would be delighted to reimburse you for any expenses you incur in sending us this material. We shall guarantee complete confidentiality for whatever data you can send us. In any publication based on this study we will not reveal either the names of the cities contacted or the identities of the individual firms involved; we will refer to each of these only by code numbers.

xxxxxxx
Page 2
July , 1973

3

If you have any questions about this survey, please do not hesitate to call us collect at (617) 495-2126. We would like to thank you in advance for cooperating in this study; and we will certainly send you a copy of our findings when the work is finished, in a few months.

Sincerely,

4

Marc J. Roberts
Associate Professor

4

Michael Hanemann
Research Associate

MJR:LH

Enclosures ( )

I. SEWER CHARGES FOR INDUSTRIAL WASTES

We are interested in the charges faced by firms who pay for sewer service at least partly on the basis of the strength of their wastes.

We would like to know the formula by which the charges on sewage strength are assessed, and also the formula for any other charges which these firms may also be paying for sewer services, such as charges based on sewage flow or water use. Since we are interested in the effects of these charges over time, we need to know both the current schedule of charges and the schedules in previous years during which the charge on sewage strength has been in operation.

We have enclosed for your convenience some data sheets (Form A) on which the charge schedules can be recorded. Since we imagine that you have changed these schedules relatively infrequently, could you please fill out a separate sheet for each schedule. There is a special sheet for the current charge scheme and additional shorter forms for each previous schedule. (If your rates have not changed since the introduction of the charge on sewage strength, just fill out the first sheet with the current rates.)

Alternatively, if you have or could make copies of the current and previous published charge schedules, please feel free to enclose these in lieu of filling out Form A.

In either case, could you please also complete the following summary table.

Please leave blank

City # ________________

CITY: ________________________________

PLEASE PUT A CHECK (√) IN COLUMN 1 BY THE YEAR IN WHICH THE CHARGE ON SEWAGE STRENGTH WENT INTO OPERATION, AND A CROSS (X) BY EACH YEAR --IF ANY--IN WHICH THE CHARGE SCHEDULE WAS SUBSEQUENTLY ALTERED. IN COLUMN 2 PLEASE WRITE THE NUMBER OF FIRMS PAYING THE CHARGE ON SEWAGE STRENGTH IN EACH YEAR SINCE ITS INTRODUCTION.

	Col 1	Col 2		Col 1	Col 2		Col 1	Col 2
1945			1955			1965		
1946			1956			1966		
1947			1957			1967		
1948			1958			1968		
1949			1959			1969		
1950			1960			1970		
1951			1961			1971		
1952			1962			1972		
1953			1963			1973		
1954			1964					

Please leave blank

City # ____.____

Form A (i) CURRENT CHARGE SCHEDULE FOR SEWER SERVICES

1. Charges Based on Sewage Strength

Does the charge only apply above a certain waste,strength? ____ Yes ____ No

If so, what is this limit :

BOD ______________

SS ______________

(Other) ______________

Charge Schedule:

BOD $__________ per __________

SS $__________ per __________

(Other) ______ $__________ per __________

Date this schedule went into effect: ______________

2. Do firms which pay the sewage strength charge also pay additional charges for sewer services based on:

Sewage Flow ☐

Water Use ☐ (Check appropriate box)

Other

__________ ☐

If so, please write this charge schedule in the space below:

Date this schedule went into effect: ______________

3. Do the above charges also cover water? ______Yes ______ No

If not,from which department could we obtain details of the water rates?

____

Please leave blank

City # ____________

Form A(ii) PREVIOUS CHARGE SCHEDULE FOR SEWER SERVICES

1. Charges Based on Sewage Strength

Did the charge only apply above a certain waste strength? ____ Yes ____ No

If so, what was this limit:

BOD ______________

SS ______________

(Other) ___ ______________

Charge Schedule:

BOD $__________ per __________

SS $__________ per __________

(Other) ____ $__________ per __________

Period during which this schedule was in effect: From ______ to ______

2. Charges Based on Sewage Flow or Water Use

Was charge based on:

Sewage Flow ☐

Water Use ☐

Other

__________ ☐

Please write the charge schedule in the space below:

Period during which this schedule was in effect: From ______ To ______

II. WASTE DISCHARGES BY INDIVIDUAL FIRMS

We would like to know the waste discharges of each firm paying a sewer service charge based on the strength of its sewage, for each year in which the charge was paid.

We are enclosing data sheets (Form B) on which this information can be recorded. Please fill out a separate sheet for each firm. There may be some firms which paid a charge based on sewage strength at one time, but which no longer pay this charge (for example, because they have reduced their sewage strength below the minimum standard). Since this is a valuable piece of information in itself, could you please fill out a copy of Form B for each of these firms, too, as well as for the firms which are still currently paying the charge on sewage strength.

If you have this data in some other form which is more convenient for you (for example, computer printout), please feel free to send it that way, instead of filling out copies of Form B. Alternatively, you may prefer to call us collect and have someone read us the information over the telephone. Whichever method you choose, we would be happy to reimburse you for any expenses incurred in sending us this data.

We would like to add the following comments in case you use Form B.

1. You will notice that we ask for the names of the firms involved. We realize that this is sometimes regarded as confidential. We are asking for this because we would like to be able to contact these firms and send them a questionnaire about their attitudes and response to the charge on sewage strength. However, WE GUARANTEE TO PRESERVE THE CONFIDENTIALITY OF THIS DATA. In any report based on this survey we will disguise the identity of your city and of the firms paying the charge on sewage strength by referring to them only through code numbers.

2. For each firm we would like to know the annual flow of wastewater and <u>either</u> the quantity <u>or</u> the concentration of wastes discharged--please record whichever is the more convenient. In addition, we would like to know the dollar amount which the firm actually paid for sewer services, if this is available.

3. We would like to have this data for each year in which the firm paid the charge based on sewage strength. However, if you monitored the strength of sewage discharges before introducing the charge, we would like to know the discharges in the four years <u>prior</u> to the introduction of the charge, if this is available. Otherwise, please start with the first year in which the firm paid the charge.

4. If the charge on sewage strength was introduced before 1955, PLEASE START WITH WASTE DISCHARGES IN 1955 AND OMIT THE EARLIER YEARS.

5. We are assuming that your data on waste discharges is recorded on an annual basis. If it is more convenient for you to use an alternative time period for describing waste discharges, please do so, and indicate the relevant time period on the form.

6. Please specify the units used for measuring wastewater flow and waste quantity or concentration, if they differ from those indicated on the form.

FORM B WASTE DISCHARGES BY INDIVIDUAL FIRMS

Please Leave Blank

City # ____________

Firm # ____________

Firm Name ____

Brief Address ____

____

Industry in which firm operates ________________________________

Does firm purchase its water from
your municipality? ________ Yes ________ NO

Please Leave Blank

City # ____________

Firm # ____________

PLEASE SPECIFY EITHER QUANTITY OR CONCENTRATION OF WASTES, WHICHEVER IS MORE CONVENIENT.

PLEASE START WITH THE FIRST YEAR IN WHICH THE FIRM PAID THE CHARGE ON SEWAGE STRENGTH (UNLESS YOU HAVE PRIOR DATA). IF THIS WOULD BE BEFORE 1955, PLEASE START WITH 1955 AND OMIT THE EARLIER YEARS.

YEAR	Wastewater Flow	Quantity Discharged			OR	Concentration of Discharge			Amount Paid (if available)
		BOD	SS	OTHER ____		BOD	SS	OTHER ____	
	mg	(millions of lbs)				(ppm)			($)
1955									
1956									
1957									
1958									
1959									
1971									
1972									

III. EVALUATION OF SEWER CHARGE SYSTEM

We are interested in learning your own personal opinion on the operation and effectiveness of the charge on sewage strength. We would appreciate it if you would indicate your name and your position in the space below.
WE GUARANTEE TO PRESERVE THE STRICT CONFIDENTIALITY OF YOUR COMMENTS.

Name : ______________________________________

Position : ___________________________________

Please leave blank
City # ____________
Respondent # _____

1. Do you have any restrictions on the types of industrial wastes which may be be discharged into your sewer system and/or any pre-treatment requirements ?

2. (a) How do you monitor the quality of industrial wastes ?

   (b) On the average, how often is this monitoring done ?

   (c) What is your estimate of how much it costs to monitor the wastes of each firm ?

   (d) Who pays this cost ?

3. In your opinion should the charge on sewage strength be based on any other waste quality parameters, besides those currently in use ?

4. Is there any other method of charging for industrial wastes that you would prefer ?

5. (a) In your opinion, has the charge on sewage strength led firms to reduce their discharge of wastes into your sewer system ? Which types of firms in which industries have been most responsive to the charge ?

(b) Of the firms which have reduced their waste discharges in response to the charge on sewage strength, was this done through:

(i) changes in plant operating procedures

(ii) the introduction of new types of production equipment

(iii) the installation of special self-treatment facilities

Could you give some specific examples ?

6. Does the industrial wasteload cause any particular operations or maintenance problems or costs for your treatment system ?

7. (a) Could you estimate what percent of the total wasteload on your sewage treatment plant comes from industrial sources ?

   (b) Could you estimate what percent of the industrial wasteload comes from firms which are paying the charge on sewage strength ?

8. Would you say that the charge on sewage strength adequately covers the additional costs of treating the wastes of those firms which pay it ?

9. Are there any other comments which you would like to make ?

FIRM SURVEY

Cover Letter

Questionnaire

HARVARD UNIVERSITY

DEPARTMENT OF ECONOMICS

Littauer Center, Room 230

CAMBRIDGE, MASSACHUSETTS 02138

Dear Sir:

I would like to ask for your help in a research project I am conducting on the economics of sewer charges for industrial wastes. I am trying to find out how firms have responded to municipal sewer service charges which are based at least partly on sewage strength, and not merely on sewage flow. Many cities are now thinking of introducing special surcharges on Biochemical Oxygen Demand or Suspended Solids concentrations of industrial wastes, and I feel that it would be extremely useful at this time to make an assessment of the effectiveness of this type of charge.

I understand that your company has been paying a charge on sewage strength since about 1971. I would very much like to know your opinion of this charge and how your company has responded to it. In addition, I would like to get a rough idea of the production levels at your plant during the period in which the charge has been in operation.

I am enclosing a short questionnaire on these matters and would be very grateful if you could arrange for someone in your organization who is familiar with this aspect of your operations to fill it out and return it to me. I can assure you that I will treat any information given to me with the strictest confidentiality. In any report or publication based on this research, I will not identify any companies or individuals; I will refer to the cities and companies involved only by code numbers.

If you have any questions, please do not hesitate to call me or my research associate, Michael Hanemann, collect at 617/495-2126. When I finish this study shortly, I will send you a copy of our findings.

Sincerely,

Marc J Roberts

Marc J. Roberts
Associate Professor

MJR:1h

Enclosure

HARVARD UNIVERSITY

DEPARTMENT OF ECONOMICS

Industrial Wastes Research Project

THE DATA, COMMENTS AND OPINIONS IN THIS QUESTIONNAIRE WILL BE TREATED WITH COMPLETE CONFIDENTIALITY. In any report based on this survey the identity of your company and the city in which it is located will be disguised through the use of code numbers.

We would appreciate it if you would indicate your name and your position in your company in the following space :

____

____

Please leave blank

City # __________

Firm # __________

This questionnaire pertains to the following establishment :

____

____

What types of products (by SIC categories if possible) are produced in this establishment ? ________________________________

What is the approximate size of the plant labor force ?

A. RESPONSE TO CHARGE ON SEWAGE STRENGTH

1. Has your company taken any special measures in response to the charge on sewage strength :

    ____ to reduce the concentration of sewage discharges

    ____ to reduce the volume of sewage discharges.

    Could you briefly describe these measures. In particular, did they involve :

    ____ changes in plant operating procedures

    ____ the use of different input materials

    ____ the introduction of new types of production equipment

    ____ the installation of special self-treatment facilities.

2. If your company did take some special measures, were they completed :

    ____ before the charge on sewage strength actually went into operation

    ____ within 6 months of the introduction of the charge

    ____ within 12 months of the introduction of the charge

    ____ within 24 months of the introduction of the charge

    ____ later (please specify).

3. Are there any other measures which your company considered taking but rejected because the charge on sewage strength was not high enough to make them economical ? Could you briefly describe these measures.

B. OUTPUT SINCE INTRODUCTION OF CHARGE ON SEWAGE STRENGTH

We would like to know how your plant production has varied during the period in which the charge on sewage strength has been in effect. You may wish to express output in physical units or in dollar terms; please use whichever is most convenient. If you prefer, we would be happy to have you provide an index number, with output or sales in the initial year set at 100 and production in the following years expressed as an appropriate multiple of the initial year's output.

Please start with output in ______, assuming that is the first year in which the charge on sewage strength was applied, and please specify units in which output is measured.

Year	Plant Production ______(units)
1960	
1961	
1962	
1963	
1964	
1965	
1966	
1967	
1968	
1969	
1970	
1971	
1972	

C. EVALUATION OF CHARGE ON SEWAGE STRENGTH

1. Do you regard the present sewer charge as a fair charge for the municipal sewage treatment services which your company receives ?

2. Is there any other method of paying for sewer services which you would prefer ?

3. Are there any other comments which you would like to make ?

APPENDIX IV.B: DATA

APPENDIX B. DATA

There are two lines for each of the 219 data points.

The first line contains: the city identify number; the firm identify number; SIZE (coded as 1, 2 rather than 0, 1); the SIC category; DFLO, DBOD, DSS, DCBD, DCSS.

The second line contains: PFLO, PBOD, PSS, PAB, PAS, PAM, LIMB and LIMS
These variables are defined in Tables IV.5 and IV.10.

154.0	1.0	2.0	6.0	7.1212	5.3684	0.0	0.7539	0.0
3.000	0.0	21.000	0.0	0.437	2.563	0.0	250.0	
154.0	2.0	1.0	6.0	1.0000	1.7330	0.0	1.7330	0.0
3.000	0.0	21.000	0.0	0.437	2.563	0.0	250.0	
154.0	3.0	2.0	6.0	0.7780	0.6512	0.0	0.8372	0.0
3.000	0.0	21.000	0.0	0.437	2.563	0.0	250.0	
154.0	4.0	2.0	1.0	1.3953	1.6810	0.0	1.2047	0.0
3.000	0.0	21.000	0.0	0.437	2.563	0.0	250.0	
154.0	5.0	2.0	6.0	0.5556	0.1456	0.0	0.2625	0.0
3.000	0.0	21.000	0.0	0.437	2.563	0.0	250.0	
154.0	7.0	2.0	1.0	1.4381	1.0429	0.0	0.7252	0.0
3.000	0.0	21.000	0.0	0.437	2.563	0.0	250.0	
112.0	2.0	1.0	9.0	1.0842	3.1459	0.0	2.9016	0.0
2.000	33.000	24.000	0.825	0.700	0.476	300.0	350.0	
112.0	3.0	1.0	1.0	0.8728	1.6380	0.0	1.8767	0.0
2.000	33.000	24.000	0.125	0.700	0.476	300.0	350.0	
71.0	1.0	2.0	4.0	0.8931	0.1334	0.0	0.1500	0.0
1.050	8.000	0. C	0.500	0.0	0.550	750.0	0.0	
155.0	4.0	2.0	6.0	1.0073	1.0131	0.0	1.0060	0.0
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
155.0	6.0	1.0	9.0	1.0033	1.0934	0.0	1.0898	0.0
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
155.0	11.0	2.0	6.0	0.8823	1.8088	0.0	2.0500	0.0
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
21.0	1.0	1.0	8.0	0.9240	0.0	1.5000	0.0	1.6234
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	2.0	1.0	8.0	0.8443	0.0	0.3000	0.0	0.3553
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	3.0	2.0	3.0	1.3656	0.0	0.5980	0.0	0.4379
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	4.0	1.0	9.0	0.5385	0.0	0.5970	0.0	1.1086
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	5.0	1.0	1.0	0.5924	0.0	0.4300	0.0	0.7258
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	6.0	1.0	8.0	0.8387	0.0	2.0000	0.0	2.3845
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	7.0	1.0	8.0	1.9890	0.0	0.1250	0.0	0.1043
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	8.0	1.0	4.0	0.7665	0.0	0.6810	0.0	0.8880

0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	9.0	1.0	4.0	0.9712	0.0	1.2300	0.0	1.2665
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	10.0	1.0	3.0	0.7825	0.0	1.0400	0.0	1.3290
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	11.0	1.0	8.0	0.5476	0.0	0.4280	0.0	0.7816
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	12.0	1.0	8.0	0.8830	0.0	0.7500	0.0	0.8493
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	13.0	1.0	7.0	1.0275	0.0	1.1150	0.0	1.0852
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	14.0	1.0	4.0	1.0492	0.0	0.8510	0.0	0.8110
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	15.0	1.0	7.0	1.4570	0.0	1.0890	0.0	0.7473
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	16.0	2.0	3.0	0.8294	0.0	0.8410	0.0	1.0140
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	17.0	2.0	8.0	1.6291	0.0	1.1740	0.0	0.7207
0.320	0.0	5.000	0.0	0.150	0.170	0.0	340.0	
21.0	18.0	2.0	3.0	0.9554	0.0	0.3580	0.0	0.3747
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	19.0	1.0	6.0	1.1930	0.0	1.6380	0.0	1.3750
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	20.0	1.0	3.0	0.7953	0.0	0.8125	0.0	1.0216
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	21.0	1.0	9.0	1.0182	0.0	2.0920	0.0	2.0550
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	22.0	2.0	2.0	1.0956	0.0	0.6620	0.0	0.6040
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	23.0	2.0	8.0	1.4194	0.0	2.5172	0.0	1.7730
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	24.0	1.0	9.0	1.0403	0.0	0.6740	0.0	0.6480
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.3	
21.0	25.0	1.0	9.0	1.1150	0.0	0.3280	0.0	0.2940
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	26.0	1.0	9.0	1.1340	0.0	0.3450	0.0	0.3040
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	27.0	2.0	1.0	1.0540	0.0	0.4030	0.0	0.3820
0.320	0.0	5.000	0.0	0.150	0.170	0.0	330.0	
21.0	28.0	1.0	7.0	0.9270	0.0	1.6180	0.0	1.7460
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	29.0	2.0	8.0	1.0180	0.0	0.8900	0.0	0.8740
0.320	0.0	5.000	0.0	0.150	0.170	0.0	350.0	
21.0	30.0	1.0	9.0	0.8650	0.0	0.3740	0.0	0.4320
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	31.0	2.0	8.3	1.5910	0.0	0.1300	0.0	0.0820
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	32.0	1.0	4.0	1.1360	0.0	1.4012	0.0	1.2330
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
21.0	33.0	1.0	9.0	0.8373	0.0	0.7059	0.0	0.8431
0.320	0.0	5.000	0.0	0.150	0.170	0.0	360.0	
11.0	1.0	1.0	2.0	0.0	0.0	0.0	1.7926	2.3180

2.000	14.400	14.400	0.390	0.390	1.220	325.0	325.0	
11.0	2.0	1.0	2.0	0.0	0.0	0.0	0.6253	0.4020
2.000	14.400	14.400	0.390	0.390	1.220	325.0	325.0	
11.0	3.0	1.0	1.0	0.0	0.0	0.0	0.9223	3.3490
2.000	14.400	14.400	0.390	0.390	1.220	325.0	325.0	
11.0	4.0	1.0	1.0	0.0	0.0	0.0	1.3360	0.5910
2.000	14.400	14.400	0.390	0.390	1.220	325.0	325.0	
152.0	21.0	1.0	9.0	0.0	0.0	0.0	0.5234	0.7766
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
133.0	6.0	2.0	2.0	0.0	0.0	0.0	1.0210	1.4776
0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0	
133.0	7.0	2.0	1.0	0.0	0.0	0.0	0.5850	0.5030
0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0	
134.0	7.0	2.0	1.0	0.0	0.0	0.0	0.4920	0.4125
1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0	
133.0	9.0	2.0	2.0	0.0	0.0	0.0	0.7560	1.0370
0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0	
133.0	12.0	1.0	8.0	0.0	0.0	0.0	0.6280	0.9300
0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0.	
11.0	3.0	1.0	1.0	0.0	0.0	0.0	0.9130	0.9960
2.000	14.400	14.400	0.390	0.390	1.220	325.0	325.0	
24.0	1.0	1.0	3.0	1.3188	1.3770	1.7274	1.0440	1.3100
1.070	16.000	16.000	0.533	0.533	0.004	400.0	400.0	
24.0	2.0	2.0	3.0	0.9867	1.1055	1.5653	1.1204	1.5864
1.070	16.000	16.000	0.533	0.533	0.004	400.0	400.0	
24.0	3.0	2.0	3.0	0.6588	0.7148	0.7348	1.0850	1.1154
1.070	16.000	16.000	0.533	0.533	0.004	400.0	400.0	
152.0	1.0	2.0	5.0	0.5707	1.5892	0.4622	2.7847	0.8099
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	2.0	2.0	6.0	1.2836	0.3106	1.1397	0.2416	0.8879
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	3.0	2.0	6.0	0.7876	0.7426	0.4764	0.9430	0.6049
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	4.0	2.0	1.0	0.7256	0.7495	0.4050	1.0329	0.5581
3.450	80.000	0. C	1.666	0.0	1.784	250.0	0.0	
152.0	5.0	1.0	2.0	1.0110	1.4544	1.6762	1.4385	1.6579
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152-0	5.0	1.0	2.0	1.0110	1.4544	1.6762	1.4385	1.6579
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	6.0	2.0	2.0	0.8270	0.8033	0.6928	0.9774	0.3377
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	8.0	1.0	9.0	0.9015	0.5473	0.8305	0.6071	0.9213
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0 .0	
152.0	9.0	1.0	9.0	1.0445	0.3700	0.6195	0.3543	0.5931
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	10.0	1.0	9.0	0.9282	0.9941	1.5264	1.0710	1.6400
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	11.0	1.0	9.0	1.0592	0.5210	0.9780	0.4920	0.9230
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0 .0	
152.0	12.0	1.0	9.0	0.7302	0.3736	0.4647	0.5117	0.6364
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	13.0	1.0	9.0	2.7012	1.5564	2.5153	0.5762	0.9312

3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	14.0	1.0	9.0	1.0013	0.5512	0.8376	0.5505	0.8365
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	15.0	1.0	9.0	0.2533	0.1351	0.3584	0.5335	1.4150
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	16.0	1.0	9.0	1.6423	1.3578	2.1021	0.8267	1.2800
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	17.0	1.0	9.0	0.7281	0.6298	0.4488	0.8650	0.6164
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	18.0	1.0	9.0	0.9009	0.3750	0.3977	0.4163	0.4414
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	19.0	1.0	9.0	1.0250	0.7279	0.4666	0.7101	0.4552
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	20.0	1.0	9.0	0.6267	0.3732	0.5045	0.5955	0.8051
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	22.0	2.0	5.0	1.2329	0.5086	3.0044	0.4125	2.4369
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
152.0	23.0	1.0	9.0	1.5583	1.3503	1.4891	0.8665	0.9556
3.450	80.000	0.0	1.666	0.0	1.784	250.0	0.0	
165.0	1.0	2.0	7.0	1.2908	1.3450	1.7741	1.0420	1.3744
0.320	10.860	11.360	0.217	0.284	-0.181	240.0	300.0	
165.0	2.0	2.0	7.0	1.2281	1.4535	1.5090	1.1835	1.2286
0.320	10.860	11.360	0.217	0.284	-0.181	240.0	300.0	
165.0	3.0	1.0	7.0	1.4601	1.9844	2.9030	1.3591	1.9884
0.320	10.860	11.360	0.217	0.284	-0.181	240.0	300.0	
41.0	2.0	2.0	4.0	1.1758	1.4315	0.8940	1.2175	0.7603
1.140	8.400	8.400	0.210	0.210	0.720	300.0	300.0	
41.0	3.0	2.0	4.0	1.5389	1.1228	0.8396	0.7296	0.5455
1.140	8.400	8.400	0.210	0.210	0.720	300.0	300.0	
41.0	4.0	2.0	1.0	2.7656	2.1082	1.1304	0.7623	0.4088
1.140	8.400	8.400	0.210	0.210	0.720	300.0	300.0	
41.0	5.0	2.0	4.0	1.0300	2.1146	2.5486	2.0530	1.2052
1.140	8.400	8.400	0.210	0.210	0.720	300.0	300.0	
41.0	6.0	2.0	2.0	1.8763	1.4522	0.4845	0.7740	0.2582
1.140	8.400	8.400	0.210	0.210	0.720	300.0	300.0	
41.0	7.0	1.0	1.0	1.4166	2.0000	2.3860	1.4116	1.6842
1.140	8.400	8.400	0.210	0.210	0.720	300.0	300.0	
41.0	8.0	1.0	4.0	1.2070	3.7632	1.6440	3.1178	1.3618
1.140	8.400	8.400	0.210	0.210	0.720	300.0	300.0	
141.0	1.0	2.0	8.0	1.0122	0.2630	3.2571	0.2600	3.2180
3.000	25.720	25.720	0.675	0.289	2.036	315.0	135.0	
141.0	2.0	1.0	8.0	1.2421	3.4616	0.1656	2.7869	0.1330
3.000	25.720	25.720	0.675	0.289	2.036	315.0	135.0	
141.0	3.0	1.0	6.0	1.0065	0.2685	23.1500	0.2668	23.0000
3.000	25.720	25.720	0.675	0.289	2.036	315.0	135.0	
141.0	4.0	2.0	6.0	1.1471	0.4967	1.8716	0.4330	1.6316
3.000	25.720	25.720	0.675	0.289	2.336	315.0	135.0	
141.0	5.0	1.0	3.0	0.9661	0.4520	1.1035	0.4678	1.1422
3.000	25.720	25.720	0.675	0.289	2.036	315.0	135.0	
141.0	6.0	2.0	8.0	1.1336	0.1760	4.5344	0.1552	4.0000
3.000	25.720	25.720	0.675	0.289	2.036	315.0	135.0	
141.0	7.0	1.0	2.0	1.4103	1.8592	0.6900	1.3183	0.3712

3.000	25.720	25.720	0.675	0.289	2.036	315.0	135.0	
71.0	2.0	2.0	3.0	1.1123	0.4338	0.4248	0.3900	0.3819
0.600	23.300	4.000	0.0	0.200	0.400	0.0	600.0	
112.0	1.0	2.0	4.0	0.6503	0.4507	0.4837	0.6931	0.7437
2.000	33.000	24.000	0.825	0.700	0.476	300.0	350.0	
112.0	4.0	1.0	9.0	0.8703	0.6194	0.4646	0.7117	0.5338
2.000	33.000	24.000	0.825	0.700	0.476	300.0	350.0	
112.0	5.0	2.0	4.0	0.9135	1.0043	0.6896	1.0994	0.7550
2.000	33.000	24.000	0.825	0.700	0.476	300.0	350.0	
112.0	6.0	1.0	9.0	1.1052	2.3830	1.9390	2.1561	1.7545
2.000	33.000	24.000	0.825	0.700	0.476	300.0	350.0	
112.0	7.0	1.0	1.0	1.0951	1.2213	0.8117	1.1152	0.7412
2.000	33.000	24.000	0.825	0.700	0.476	300.0	350.0	
112.0	8.0	1.0	9.0	0.6292	0.5521	0.5081	0.9775	0.8075
2.000	33.000	24.000	0.825	0.700	0.476	300.0	350.0	
51.0	1.0	2.0	4.0	1.2299	2.0682	1.1557	1.6815	1.2661
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	2.0	2.0	3.0	1.1356	4.0945	2.7980	3.6055	2.4638
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	3.0	2.0	4.0	0.9791	0.7309	1.3856	0.7465	1.4151
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	4.0	1.0	9.0	1.0646	0.9601	2.3732	0.9018	2.2291
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	6.0	2.0	4.0	0.7732	1.0051	0.9445	1.2999	1.2862
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	7.0	2.0	4.0	1.0920	0.7885	0.5763	0.7220	0.5277
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	8.0	2.0	2.0	1.0451	2.8486	1.4094	2.7256	1.3486
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	9.0	1.0	2.0	0.8763	1.9062	0.9165	2.1751	1.0458
0.500	30.000	30.300	0.625	0.625	-0.749	250.0	250.0	
51.0	10.0	1.0	9.0	0.7784	0.9314	1.2676	1.1966	1.6285
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	11.0	1.0	1.0	0.2797	1.0453	2.1503	3.7373	1.6882
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	12.0	2.0	4.0	0.4877	1.3858	1.2215	2.8413	2.5045
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	16.0	2.0	4.0	0.9122	1.3459	0.9757	1.4754	1.0696
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	17.0	1.0	9.0	0.7298	2.1475	2.5797	2.9425	3.5348
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	19.0	2.0	4.0	4.7915	9.9221	8.1610	2.0707	1.7032
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	20.0	1.0	4.0	1.0262	0.3302	2.6519	3.2027	2.5840
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	22.0	1.0	3.0	0.5924	1.7308	0.7237	2.9213	1.2214
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	23.0	1.0	4.0	1.2789	0.9194	1.2789	0.7189	1.0000
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	24.0	1.0	4.0	0.9274	1.0563	0.4809	1.1390	0.5185
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	25.0	1.0	9.0	0.9617	2.3348	1.4763	2.4277	1.5350

0.500	30.030	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	26.0	1.0	4.0	1.2359	0.5123	0.5292	0.4145	0.4282
0.500	30.000	33.000	0.625	0.625	-0.749	250.0	250.0	
51.0	27.0	1.0	4.0	0.8908	0.1950	0.3606	0.2189	0.4049
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	28.0	1.0	4.0	1.0424	0.5958	0.4628	0.5715	0.4440
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	31.0	1.0	3.0	0.9651	1.3377	0.5743	1.3860	0.5950
0.500	30.000	30. 000	0.625	0.625	-0.749	250.0	250.0	
51.0	32.0	2.0	2.0	1.2806	1.5690	1.1683	1.2251	0.9122
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
51.0	33.0	1.0	2.0	1.1468	2.9356	3.9191	2.5597	3.4173
0.500	30.000	30.000	0.625	0.625	-0.749	250.0	250.0	
153.0	1.0	2.0	6.0	0.9274	1.0304	1.2365	1.1110	1.3330
2.450	23.000	30.000	0.575	0.750	1.126	300.0	300.0	
153.0	2.0	2.0	6.0	0.9540	0.8256	0.6071	0.8654	0.6364
2.450	23.000	30.000	0.575	0.750	1.126	300.0	300.0	
153.0	4.0	2.0	4.0	1.1754	1.3655	1.2856	1.1618	1.0940
2.450	23.030	30.000	0.575	0.750	1.126	300.0	300.0	
153.0	7.0	2.0	6.0	2.8570	2.9490	2.3460	1.0323	0.8211
2.450	23.000	30.000	0.575	0.750	1.126	300.0	300.0	
153.0	8.0	2.0	1.0	1.2880	1.3846	1.7890	1.0750	1.3890
2.450	23.000	30.000	0.575	0.750	1.126	300.0	300.0	
153.0	10.0	1.0	9.0	1.4290	1.5230	1.5750	1.0656	1.1020
2.450	23.000	30.000	0.575	0.750	1.126	300.0	300.0	
153.0	13.0	2.0	4.0	1.1960	1.5890	0.9410	1.3290	0.7870
2.450	23.000	30.000	0.575	0.750	1.126	300.0	300.0	
153.0	14.0	2.0	5.0	0.7730	0.9300	1.5720	1.2030	2.0330
2.450	23.000	30.000	0.575	0.750	1.126	300.0	300.0	
153.0	17.0	1.0	8.0	0.5970	7.5820	4.2800	12.7000	7.1700
2.450	23.000	33.000	0.575	0.750	1.126	300.0	300.0	
153.0	21.0	2.0	1.0	1.4740	1.2590	1.5790	0.8540	1.0714
2.450	23.000	30.000	0.575	0.750	1.126	300.0	300.0	
153.0	20.0	2.0	8.0	0.6090	2.7180	0.5330	4.4625	0.8750
2.450	23.000	30.000	0.575	0.750	1.126	300.0	300.0	
153.0	19.0	2.0	2.0	0.4840	0.6550	0.5001	1.3540	1.0330
2.450	23.000	30.000	0.575	0.750	1.126	300.0	300.0	
153.0	22.0	1.0	1.0	1.3110	1.1140	1.2020	0.8500	0.9170
2.450	23.000	30.000	0.575	0.750	1.126	300.0	300.0	
133.0	1.0	2.0	1.0	1.8700	1.7380	2.9750	0.9294	1.5900
0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0	
134.0	1.0	2.0	1.0	0.9990	0.3903	0.3070	0.3907	0.3080
1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0	
133.0	2.0	1.0	3.0	1.1950	0.6560	1.1126	0.5490	0.9310
0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0	
134.0	2.0	1.0	3.0	1.1390	1.0190	1.2520	0.8950	1.0990
1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0	
133.0	3.0	1.0	1.0	0.7930	0.5800	0.9450	0.7314	1.1914
0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0	
134.0	3.0	1.0	1.0	1.7700	0.6430	0.8490	0.3630	0.4800
1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0	
133.0	4.0	1.3	8.0	2.8660	4.1530	2.5600	1.4500	0.8930	

	0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0
134.0	4.0	1.0	8.0	1.0795	0.3494	0.2140	0.3240	0.1984
	1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0
133.0	5.0	1.0	9.0	1.4360	0.8240	1.3910	0.5740	0.9690
	0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0
134.0	5.0	1.0	9.0	0.8425	1.6140	0.5090	1.9153	0.6042
	1.340	15.000	25.000	0.251	0.502	0.577	209.0	241.0
134.0	6.0	2.0	2.0	0.9093	1.4510	0.7274	1.5960	0.8000
	1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0
133.0	8.0	1.0	2.0	1.4830	1.5920	2.1795	1.0740	1.4700
	0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0
134.0	8.0	1.0	2.0	1.2570	1.4940	1.2667	1.1883	1.0080
	1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0
134.0	9.0	2.0	2.0	1.1150	1.8510	1.2000	1.6610	1.0760
	1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0.
133.0	10.0	1.0	4.0	1.9320	1.6000	2.1850	0.8280	1.1310
	0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0
134.0	10.0	1.0	4.0	0.7490	0.2540	0.1030	0.3385	0.1369
	1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0
133.0	11.0	1.0	1.0	1.7500	1.4000	3.7330	0.8000	2.1330
	0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0
134.0	11.0	1.0	1.0	0.9560	0.9300	0.4720	0.9730	0.4940
	1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0
134.0	12.0	1.0	8.0	0.6550	1.1600	0.3110	1.7710	0.4750
	1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0
133.0	13.0	2.0	2.0	1.1740	1.1060	1.4120	0.9420	1.2030
	0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0
134.0	13.0	2.0	2.0	1.4630	1.9130	1.6150	1.3070	1.1040
	1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0
133.0	14.0	1.0	4.0	2.2090	1.1940	0.5650	0.5400	0.2560
	0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0
134.0	14.0	1.0	4.0	0.5070	0.4550	0.3170	0.8970	0.6260
	1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0
133.0	15.0	2.0	2.0	1.1450	0.9870	1.0770	0.8620	0.9400
	0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0
134.0	15.0	2.0	2.0	1.1290	1.3330	1.6860	1.1804	1.4930
	1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0
133.0	16.0	1.0	9.0	0.9530	0.7020	0.7040	0.7360	0.7390
	0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0
134.0	16.0	1.0	9.0	0.9200	0.8300	0.9550	0.9100	1.0380
	1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0
113.0	8.0	1.0	7.0	1.0538	0.8440	0.5075	0.8013	0.4820
	0.480	4.000	2.000	0.0	0.0	0.480	0.0	0.0
115.0	8.0	1.0	7.0	1.0280	1.2670	1.7530	1.2320	1.7060
	0.580	5.400	2.700	0.0	0.0	0.580	0.0	0.0
113.0	9.0	2.0	8.0	2.2480	2.6428	1.7963	1.1756	0.7990
	0.480	4.000	2.000	0.0	0.0	0.480	0.0	0.0
115.0	9.0	2.0	8.0	3.4240	3.1740	2.1270	0.9270	0.6210
	0.580	5.400	2.700	0.0	0.0	0.580	0.0	0.0
113.0	1.0	2.0	7.0	0.6686	1.4470	10.1570	2.1640	15.1920
	0.480	4.000	2.000	0.0	0.0	0.480	0.0	0.0
115.0	1.0	2.0	7.0	1.7060	5.8430	25.7100	3.4230	15.0680

0.580	5.400	2.700	0.0	0.0	0.580	0.0	0.0	
113.0	2.0	1.0	8.0	0.3823	0.8990	4.4730	2.3520	11.7000
0.480	4.000	2.000	0.0	0.0	0.480	0.0	0.0	
115.0	2.0	1.0	8.0	0.4470	1.3140	4.7230	2.9420	10.5760
0.580	5.400	2.700	0.0	0.0	0.510	0.0	0.0	
113.0	4.0	2.0	7.0	2.4200	0.8776	0.5650	0.3630	0.2330
0.480	4.000	2.000	0.0	0.0	0.480	0.0	0.0	
115.0	4.0	2.0	7.0	2.4850	1.3820	0.3670	0.5570	0.1475
0.580	5.400	2.700	0.0	0.0	0.580	0.0	0.0	
113.0	5.0	2.0	7.0	2.9670	0.4040	0.4800	0.1360	0.1617
0.480	4.000	2.000	0.0	0.0	0.480	0.0	0.0	
133.0	17.0	1.0	9.0	1.6500	1.1020	1.6430	0.6680	0.9960
0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0	
134.0	17.0	1.0	9.0	0.8120	0.6800	0.6240	0.8370	0.7680
1.340	15.000	25.000	0.261	0.502	0.577	209.0	241.0	
133.0	18.0	1.0	1.0	1.1620	0.0720	3.1690	0.0620	2.7270
0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0	
133.0	19.0	1.0	2.0	1.3600	0.7010	1.2930	0.5160	0.9510
0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0	
133.0	20.0	1.0	2.0	0.7520	0.9360	1.7600	1.2450	2.3400
0.936	9.000	12.000	0.157	0.241	0.538	209.0	241.0	
111.0	1.0	2.0	4.0	0.8330	1.0414	1.1290	1.2500	1.3550
0.935	13.360	9.360	0.0	0.0	0.935	0.0	0.0	
155.0	1.0	2.0	5.0	0.8123	1.8620	1.3220	2.2920	1.6270
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
155.0	2.0	2.0	4.0	1.2606	1.1149	0.7170	0.8780	0.5640
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
155.0	3.0	2.0	6.0	1.4820	2.3540	2.0100	1.5880	1.3560
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
155.0	5.0	2.0	5.0	0.9507	3.5510	1.2240	3.7350	1.2880
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
155.0	7.0	2.0	5.0	1.3580	2.0830	1.6597	1.5340	1.2220
1.872	90.000	9.000	0.225	0.247	1.400	300.0	330.0	
155.0	8.0	1.0	9.0	0.9051	1.0470	0.3023	1.1560	0.3340
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
155.0	9.0	1.0	9.0	1.0304	0.9896	0.4095	0.9604	0.3970
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
155.0	10.0	1.0	9.0	1.3526	0.0642	1.2727	0.0471	0.9409
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
155.0	12.0	1.0	9.0	0.5379	1.0253	0.0559	1.9060	0.1038
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
155.0	13.0	1.0	2.0	0.7004	0.7636	0.0382	1.0902	0.0544
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
155.0	14.0	1.0	9.0	0.7850	1.7687	1.2331	2.2530	1.5708
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
155.0	15.0	2.0	6.0	0.9668	1.4007	0.9618	1.4480	0.9948
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
155.0	16.0	2.0	2.0	0.8967	0.9271	1.2017	1.0330	1.3400
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
155.0	17.0	1.0	1.0	3.2554	0.0478	0.9791	0.0146	0.3007
1.872	9.000	9.000	0.225	0.247	1.400	300.0	330.0	
23.0	1.0	2.0	2.0	0.0	0.0	0.0	2.0447	0.0

```
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0   2.0   2.0   2.0   0.0      0.0      0.0      1.2778   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0   3.0   1.0   1.0   0.0      0.0      0.0      0.6902   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0   5.0   2.0   3.0   0.0      0.0      0.0      0.6959   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0   6.0   2.0   1.0   0.0      0.0      0.0      0.4383   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0   7.0   1.0   2.0   0.0      0.0      0.0      1.2610   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0   8.0   1.0   8.0   0.0      0.0      0.0      1.1068   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0   9.0   1.0   9.0   0.0.     0.0      0.0      1.4048   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0  10.0   2.0   2.0   0.0      0.0      0.0      0.3288   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0  11.0   1.0   3.0   0.0      0.0      0.0      0.4229   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0  13.0   2.0   3.0   0.0      0.0      0.0      0.6964   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0  14.0   2.0   3.0   0.0      0.0      0.0      0.8932   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0  15.0   2.0   3.0   0.0      0.0      0.0      1.2713   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0  16.0   1.0   1.0   0.0      0.0      0.0      0.9883   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0  17.0   1.0   1.0   0.0      0.0      0.0      0.5554   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0  18.0   1.0   4.0   0.0      0.0      0.0      1.0515   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0  19.0   2.0   1.0   0.0      0.0      0.0      2.3617   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
23.0  26.0   1.0   3.0   0.0      0.0      0.0      1.0684   0.0
  1.069    8.000    0.0      0.200    0.0      0.869    300.0    0.0
```